

PAUESIA COLUMBIANA, N. SP.
(HYMENOPTERA: BRACONIDAE: APHIDIINAE) ON JUNIPER APHIDS,
AND A KEY TO RELATED SPECIES

K. S. PIKE, P. STARÝ, G. GRAF, AND D. ALLISON

(KSP) Entomologist and (DA, GG) Research Technicians, Washington State University, Irrigated Agriculture Research and Extension Center, 24106 N Bunn Road, Prosser, WA 99350, U.S.A. (e-mail: kpike@tricity.wsu.edu); (PS) Entomologist, Institute of Entomology, Academy of Sciences of the Czech Republic, České Budějovice, Czech Republic

Abstract.—*Pauesia columbiana* Pike and Starý, n. sp., reared from *Cinara burrilli* (Wilson) on *Juniperus occidentalis* in Oregon is described. The North American species of *Pauesia* are reviewed in relation to a newly introduced grouping of the genus, and a key is provided for species of one of the two groups.

Key Words: aphid, parasitoid, *Cinara*, *Pauesia*

Research on aphidiine parasitoids in the Pacific Northwest has led to the discovery of numerous new species and aphid host relationships (Pike et al. 2000). The genus *Pauesia* Quilis is one of more than a dozen different aphidiine genera in western North America. Its members are restricted to utilizing conifer-feeding aphids in the subfamily Lachninae, the most common being in the genus *Cinara* Curtis. In the present work, a new species of *Pauesia* reared from *Cinara burrilli* (Wilson) feeding on *Juniperus occidentalis* Hook in Oregon is described, a finding which has prompted a closer study of the genus. The North American *Pauesia* are reviewed, a new diagnostic character involving apical setae on the ovipositor sheath is presented to distinguish new groupings, and a key is provided for species of one of two groups. Group 1 is keyed; Group 2 is not keyed because of a lack of available quality material to study.

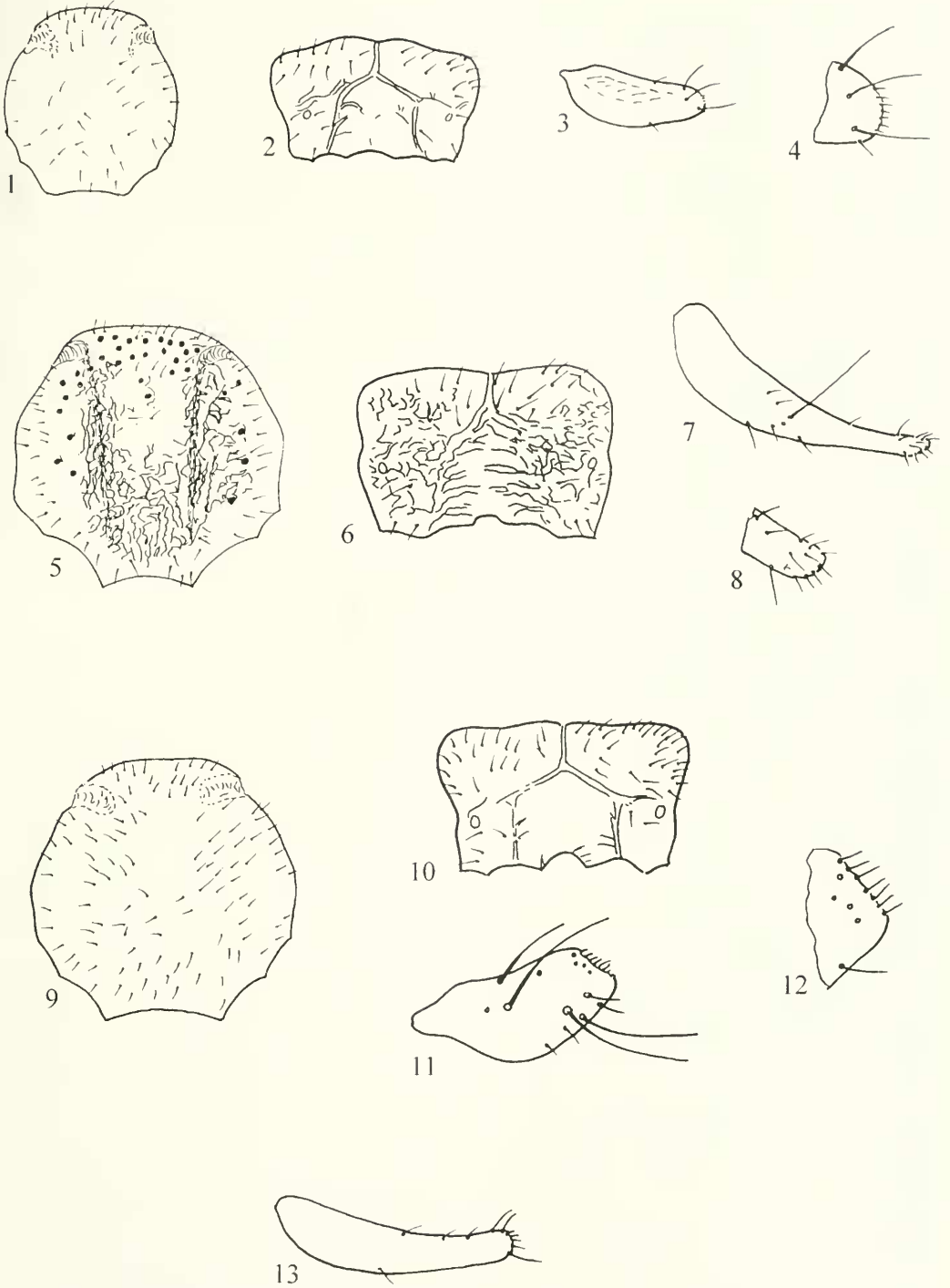
MATERIAL AND METHODS

Material evaluated.—Museum specimens afforded fundamental material for compar-

ative morphological evaluation and review. Included was an examination of separate body parts preserved in glycerine-containing glass capsules obtained from the late C. F. Smith, North Carolina State University, Raleigh. A large part of the study included *Pauesia* reared from authors' collections of determined aphids taken from a range of Pacific Northwest habitats (Pike and Starý 1996, Pike et al. 1996). In some cases, it was necessary to dissect and slide mount specimens for more detailed view. In such cases, specimens were boiled in 10% KOH for 20–60 seconds, washed in distilled water, and then mounted in DeSwann medium.

References.—References used to understand original descriptions, and for comparison with type material, taxonomic lists, and description of new species included Gahan (1911), Smith (1944), Mackauer (1968), Mackauer and Starý (1967), Marsh (1979, 1991), Starý and Remaudière (1982), Pike and Starý (1996), and Pike et al. (1996, 2000).

Diagnostic characters.—Morphological nomenclature followed prevalently Huber



Figs. 1-13. Various features of *Paesia* (drawn from females, in different scale). 1-4, *P. altaianensis*. 1, Mesonotum. 2, Propodeum. 3-4, Ovipositor sheath and apex (close-up). 5-8, *P. bicolor*. 5, Mesonotum. 6, Propodeum. 7-8, Ovipositor sheath and apex (close-up). 9-12, *P. juniperaphidis*. 9, Mesonotum. 10, Propodeum. 11, Ovipositor sheath and apex (close-up). 13, *P. pinaphidis*. Ovipositor sheath.

and Sharkey (1993). Sculpturing of the mesonotum and propodeum are characters generally used to define the species (Gahan 1911, Smith 1944). We have found it advisable to make observations of both dry material and slide-mounted material. In slide form, setae, circular pits, and rugosities, are often more readily distinguished. The circular pits on the mesonotum referred to by Gahan (1911) and Smith (1944) may occur more or less on all lobes (Fig. 22), merely at the base (Fig. 16), or in concert with conspicuous rugosities (Fig. 5). Other characters of the mesonotum include granulation or feeble rugosities. Similarly, the propodeum also possesses useful characters. The central areola may be well-defined, almost smooth, with few cross-carinae (Figs. 2, 10), or coarsely rugose with numerous cross-carinae (Figs. 6, 17). In some species, the longitudinal carinae may be significantly reduced to absent.

Here we introduce the shape of the setae at the apex of the ovipositor sheaths as a new diagnostic character. These setae are of two types: (1) their base is either simple (Figs. 4, 8, 12, 15, 19) or (2) tubiform (Figs. 21, 23). The character is best viewed when specimens are dissected, slide-mounted, and observed at a minimum of 200× magnification.

Sedlag (1971) emphasised the apparent importance of different types of ovipositor sheaths and accessory prongs in *Pauesia* and related genera. He distinguished four morphological types. The differences were presumed to be due to such factors as strong ant attendance, high mobility of host aphids and their occurrence between conifer needles. In a broader sense, Starý (1976) supported this approach, by distinguishing two basic types of ovipositor sheaths in *Pauesia*, and raising two groups to subgeneric level (*Pauesia* Quilis s. str., type species: *Pauesia albuferensis* Quilis, 1931, = *unilachni* Gahan 1927; and *Paraphidius* Starý 1958, type species: *Aphidius californicus* Ashmead 1889). Later, Sedlag and Starý (1980) described another subgenus,

Pauesiella from Central Europe, which manifests a spatulate-shaped ovipositor sheath with a strongly narrowed apical portion and bearing a group of strong, long setae in its dorso-apical fifth. Kiriac (1993) reviewed and keyed the Palaearctic species of *Pauesia* which manifest acutely narrowed ovipositor sheaths, compared to the prevailing broad oval shape. However, he did not take into consideration the differences in the shape of the apical setae.

Regarding setae on the apical portion of the sheaths, the tubiform type appeared initially to be associated with the broadly oval-shaped sheaths (Fig. 20), and the simple type to be associated with the narrowed arcuate shape (Figs. 7, 14), but some species such as *P. juniperaphidis* (Fig. 11), *P. xanthothera* (Fig. 18), *P. salignae* (Fig. 23), and others, varied from this association.

Abbreviations.—The following are used in the text for collections: USNM = National Museum of Natural History, Smithsonian Institution, Washington, DC; CFS = C. F. Smith collection, Raleigh, NC; WSU = Washington State University collection, Prosser, WA.

REVIEW OF NORTH AMERICAN *PAUESIA* SPECIES, INCLUDING SPECIES FROM MEXICO

The list below includes all new, and previous classified species (Marsh 1979, 1991; Pike and Starý 1996; Pike et al. 2000; Starý and Remaudière 1982). The generic classification by Marsh (1979) is followed, except that the species are arranged in two groups based on the apical setae of the ovipositor sheath.

Group 1. Setae at ovipositor sheath apex with simple base:

- P. ahtanumensis* Pike and Starý (Figs. 1–4)
- P. bicolor* (Ashmead) (Figs. 5–8)
- P. columbiana* sp.n. (Figs. 24–32)
- P. juniperaphidis* (Gahan) (Figs. 9–12)
- P. pinaphidis* (Ashmead) (Fig. 13)
- P. scorpinica* (Smith) (Figs. 14–15)
- P. xanthothera* (Smith) (Figs. 16–19)

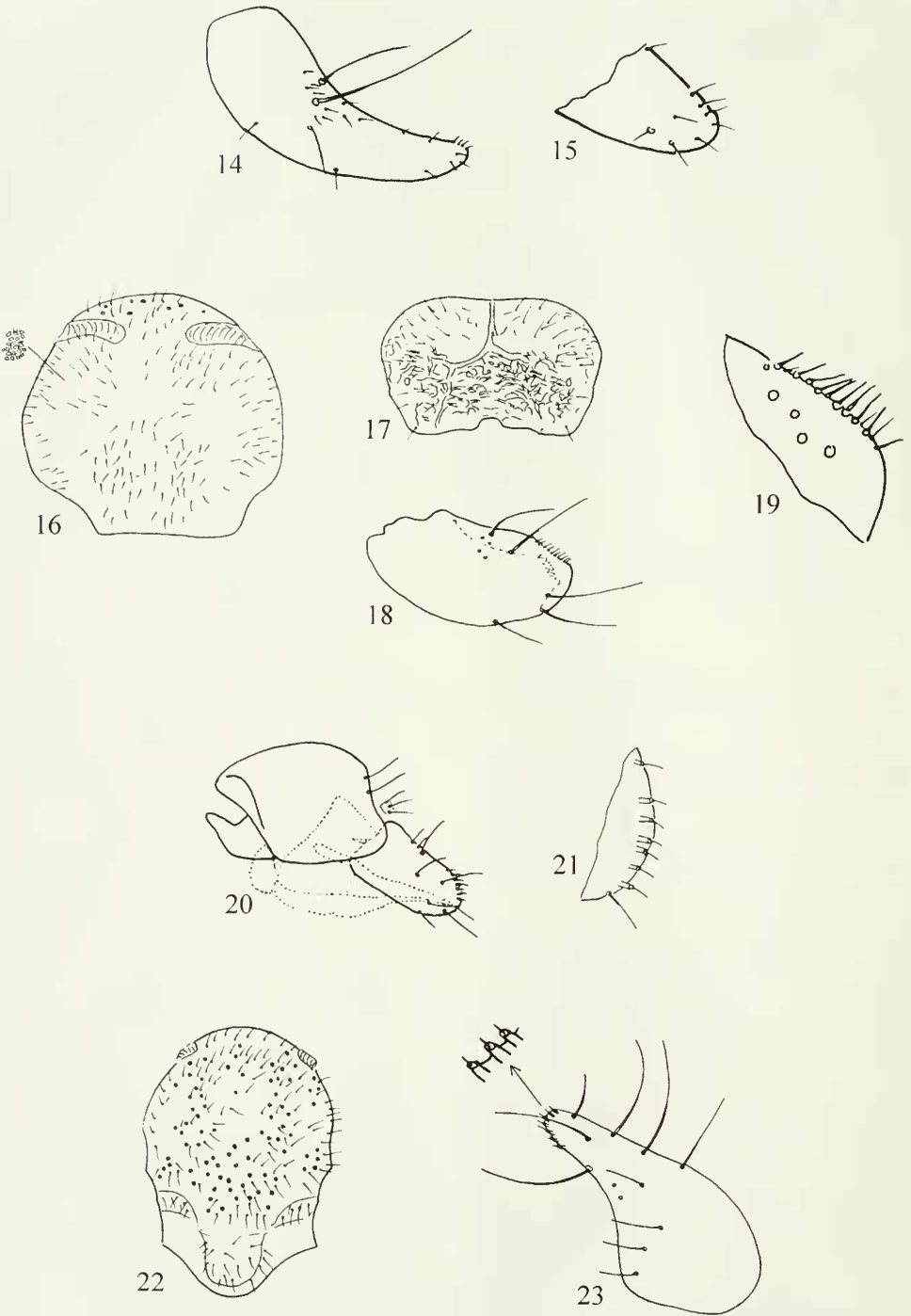
Group 2. Setae at ovipositor sheath apex with tubiform base:

- P. californica* (Ashmead)
- P. cinaravora* Marsh
- P. gillettei* (Gahan)
- P. macrogaster* (Ashmead)
- P. nigrovarya* (Provancher)
- P. paltonis* Pike and Starý
- P. ponderosae* Pike and Starý (Figs. 20–21)
- P. ponderosaecola* Pike and Starý
- ? *P. procephali* (Ashmead)
- P. pseudotsugae* Pike and Starý
- P. rufithorax* Starý and Remaudière (Mexico)
- P. rugosa* Starý and Remaudière (Mexico) (Fig. 22)
- P. salignae* (Watanabe) (Fig. 23)
- P. takomaensis* (Smith)
- P. varigata* (Smith)

GROUP 1—ANNOTATED LISTING OF
MATERIAL EXAMINED

- P. alatanumensis* Pike and Starý. WSU—ex *Cinara ponderosae* (Wilson) on *Pinus ponderosa* and *Pinus* sp. [material examined from Idaho, Montana, and Washington (see: Pike and Starý 1996; Pike et al. 1996, 2000)].
- P. bicolor* (Ashmead). USNM—1/Maryland, Montgomery Co., Takoma Park [parasitoids labelled as *Aphidius bicolor* Ashm. det. Gahan; *Aphidius bicolor* Ashm. det. C. F. Smith, C. N. Ainslie collection]. 2/Wisconsin, Oneida Co., Amer. Legion St. For., 16 & 24-VII-1957, ex aphids on *Pinus banksiana* [parasitoids labelled as *Aphidius* (*P.*) *bicolor* Ashm. det. Mues, coll. P. A. Jones] [Figs. 5–8 drawn from this material]. CFS—Ohio, Kocking Co., 26-VII-1938, ex *Cinara strobi* (Fitch)? [parasitoids labelled as 468 and 471, *Aphidius bicolor* Ashmead, det. C. F. Smith]. WSU—Idaho, Boundary Co., Bonners Ferry, 29-VII-1996, ex *Cinara* sp. on *Pinus contorta*.
- P. columbiana*, n.sp. See description below.

- P. juniperaphidis* (Gahan). USNM—Colorado, Boulder Co., Boulder [parasitoids labelled as 61600, 944, antenna 22 segments, type, USNM 14361, *Aphidius juniperaphidis*; allo-lectotype]. CFS—Colorado, Boulder Co., Boulder, 6-VI-1908 [parasitoids labelled as Type 944, paratype no. 14361 USNM, *A. juniperaphidis*]. WSU—Washington, Yakima Co., Yakima Arboretum, 3-VI-94, ex *Cinara pilicornis* (Hartig) on *Picea pungens*.
- P. pinaphidis* (Ashmead). USNM—1/Florida, Duval Co., Jacksonville [parasitoid labelled as type, *Aphidius*, *Aphidius* (*pinaphidis*) = *bicolor* det. C. F. Smith, coll. Ashmead]. 2/Louisiana, Orleans Parish, New Orleans, 10 & 25-IV, *Pinus palustris* [parasitoids labelled as *Aphidius pinaphidis* Ashm., det. Gahan, No. 24504, coll. H. K. Plank]. 3/Florida, Alachua Co., Gainesville, ex *Lachnus pini* [parasitoid labelled as *Aphidius pinaphidis* Ashm. det. Gahan, coll. A. C. Mason].
- P. scorpinica* (Smith). USNM—1/Virginia, Fairfax Co., Vienna, 18-IV-1915, on pine [parasitoids labelled as *Aphidius scorpinicus* det. C.F. Smith; allotype, *Aphidius scorpinicus*, coll. R. A. Cushman]. 2/Virginia, Fairfax Co., Vienna, 19-IV-1912, on pine, coll. J. C. Bridgwell. CFS—Virginia, Fairfax Co., Vienna, 27-III-1914, on pine, coll. R. A. Cushman [parasitoid labelled as female paratype, *Aphidius scorpinicus* sp. n. det. C.F. Smith].
- P. xanthothera* (Smith). USNM—1/North Carolina, Wake Co., Raleigh, 20-VII-1940, ex black pine aphid [parasitoid labelled as Allotype *Aphidius xanthotherus* sp. n. det. C.F. Smith, coll. S.C. Schnell]. 2/Virginia, Norfolk City Co., Norfolk, 14-V-1931, ex *Dilachnus strobi* Fitch [parasitoid labelled as 6805, paratype *Aphidius xanthotherus* Smith, coll. G.E. Gould] [Figs. 16–19 drawn from this material]. CFS—North Carolina, Raleigh, 20-VII-1940, ex black pine aphid [parasitoid labelled as paratype, *Aphidius xanthotherus* Smith, coll. S. C. Schnell].



Figs. 14-23. Various features of *Pauesia* (drawn from females in different scale). 14-15, *P. scorpinica*. Ovipositor sheath and apex (close-up). 16-19, *P. xanthothera*. 16, Mesonotum. 17, Propodeum. 18-19, Ovipositor sheath and apex (close-up). 20-21, *P. ponderosae*. 20, Genitalia. 21, Ovipositor sheath apex with tubiform base setae. 22, *P. rugosa*. Mesonotum. 23, *P. saliguae*. Ovipositor sheath and apex (close-up).

DESCRIPTION

Pauesia columbiana Pike and Starý,
new species
(Figs. 24–32)

Diagnosis.—The new species is similar to *P. juniperaphidis* (Gahan), which is also associated with *Cinara* aphids on *Juniperus*. It is easily distinguished from the latter species by the prevalent yellow coloration of the body, by the sculpture of the propodeum and, less distinctly, by the mean number of antennal segments.

Etymology.—Named after the Columbia River.

Female description.—Eye medium sized, with sparse setae. Malar space 0.4 of eye length. Tentorio-ocular line 0.8 to equal to intertentorial line. Antenna 18–19 (17, 20) segmented, not thickened to apex, and length about as long as head, mesosoma, and half of metasoma. Flagellomere 1 (F1) (Fig. 27) twice as long as broad, with 2–3 longitudinal placodes; F2 (Fig. 27) equal to F1, with 3 placodes. Middle flagellomeres (Fig. 28) as broad as basal segments.

Mesosoma: Mesonotum (Fig. 24) with notaulices distinct anteriorly, effaced on disc, with sparse setae, feebly rugose (Fig. 25). Propodeum (Fig. 29) areolated, areola inside with irregular carinae to rugosities, lateral longitudinal carinae irregular to rugose.

Forewing (Fig. 30): Stigma length about 2.5 to 3.0 times width; distal abscissa of R1 (= metacarpus) somewhat shorter than length of stigma; rs vein somewhat shorter than width of stigma, subequal to 3/Rs vein; 2/Rs vein shorter than rs.

Metasoma: Petiole (Fig. 26) length 2.5 to 3.0 width at spiracles, with sparse long setae in the apical portion, rugose, about 0.6 wider at apex than at spiracles.

Genitalia (Fig. 31): Apical setae of ovipositor sheath with simple bases (Fig. 32).

Coloration: Head brownish, frontal part yellowish, palpi yellow, mandible with brownish apices, antenna brown, scape lighter. Mesosoma yellow, lower part of

mesopleuron with brown spot, metanotum with darker patterns. Wing venation brown, stigma brown. Legs yellow, pretarsi brown. Metasoma yellow, ovipositor sheaths dark brown.

Length of body: About 2.2 to 2.3 mm.

Male description.—Antenna 20–21 (+19) segmented. Coloration: Head brown with yellowish face and inner orbits. Antenna light brown, palpi yellow. Mesosoma yellow brown, base of the central lobe of mesonotum, lower part of mesopleura, metanotum, and propodeum brown or merely with brownish patterns. Scutellum yellow brown. Wing venation brown. Legs yellow, apices of tarsi infuscated. Metasoma yellow brown, darkened to apex, petiole yellow.

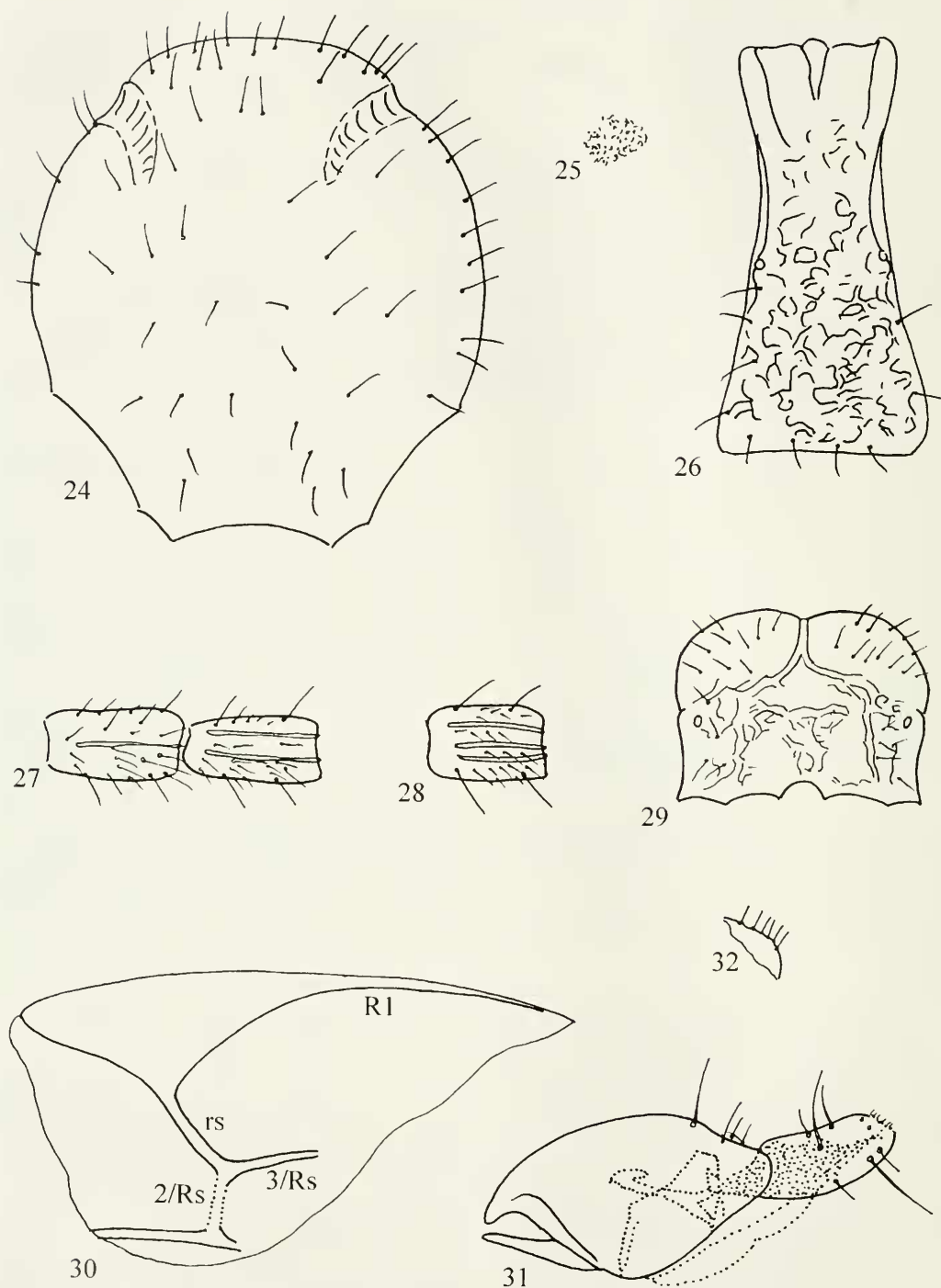
Material.—Holotype (♀) ex *Cinara burrilli* (Wilson)—USA, Oregon, Grant County, Hwy 7, 6 miles West of Whitney, 27-VII-2000, on *Juniperus occidentalis*, WSU Sample AOG582, coll. George and Della Graf. Deposited in USNM.

Paratypes: 11 ♀, 10 ♂ (sample AOG582), same data as holotype. Deposited in part in WSU and collection of P. Starý, České Budějovice, Czech Republic. 1 ♀ (sample 99K068) ex *Cinara burrilli* (Wilson)—USA, Oregon, Wasco County, Cow Canyon, 2 miles N of Antelope Junction, 24-IX-99, on *Juniperus occidentalis*, coll. K. Pike and G. Graf. Deposited in WSU.

STATUS AND SEPARATION OF *PAUESIA*
SCORPINICA (SMITH) AND RELATED SPECIES

Smith (1944) redescribed *P. bicolor* (Ashmead), and distinguished another species, *P. scorpinica* as a new species, while suppressing *P. pinaphidis* (Gahan) as a new synonym of *bicolor*. Mackauer (Mackauer and Starý 1967, Mackauer 1968) reclassified *pinaphidis* as a valid species, but placed *scorpinica* as a new synonym of *bicolor*. This classification was followed later by Marsh (1979).

In the present study, we recognize all of the aforementioned taxa (*bicolor*, *pinaphidis*, and *scorpinica*) as distinct, valid species. They are comparable in overall col-



Figs. 24–32. Various features of *Paesia columbiana*, female paratypes (illustrations not to equal scale). 24, Mesonotum. 25, Surface detail of central lobe of mesonotum. 26, Petiole. 27, Flagellomere 1 and 2. 28, Flagellomere 8. 29, Propodeum. 30, Forewing, in part (terminology after Huber and Sharkey 1993). 31, Genitalia. 32, Ovipositor sheath apex (close-up).

oration and in the more or less large circular pits on the mesonotum. *Pauesia bicolor* and *P. scorpinica* agree in the number of antennal segments (female, 21–22), but the shape and the distribution of the setae on the ovipositor sheaths are different, as correctly described and figured by Smith (1944). *Pauesia pinaphidis* manifests ovipositor sheaths similar to *P. bicolor*, but the dense circular pits on the mesonotum are distinct from *P. bicolor*. Also, the 18–19 segmented antenna (female) of *P. scorpinica* is an indication that the species is different from *P. bicolor* and *P. pinaphidis* (Gahan 1911). The variation of “19–22” antennal segments in the redescription of *bicolor* by Smith (1944) is due to an apparent confusion of the two species. In the USNM material, even the series of “*bicolor* Ashmead” and (*pinaphidis*) = *bicolor*; det. C. F. Smith, with an earlier label *pinaphidis*, det. Gahan are separated and correspond to distinct species. In general, the material available on *pinaphidis* is relatively poor, and may need to be reexamined when new material becomes available.

KEY TO NORTH AMERICAN SPECIES OF
PAUESIA, GROUP 1 (FEMALES)

[Group character: Setae with simple base at apex of ovipositor sheaths]

- 1. Ovipositor sheath slender and rather narrowed to apex (Figs. 7, 13) to claw-shaped (Fig. 14) 2
- Ovipositor sheaths broader, suboval, not conspicuously narrowed to the apex (Figs. 3, 11, 18) 4
- 2(1). Ovipositor sheath slender and rather narrowed to apex, with 1 (to 0?) long setae in middle (Figs. 7, 13). Antenna 18–19 or 21–22 segmented. Mesonotum with dispersed or dense large circular pits (Figs. 5, 16) . . . 3
- Ovipositor sheaths slender, claw-shaped, with several long setae in middle (Fig. 14). Antenna 21–22 segmented. Mesonotum with dispersed large circular pits . . . *scorpinica*
- 3(2). Antenna 18–19 segmented. Mesonotum coarsely rugose with dense large circular pits, the distance between them approximately equal to pit diameter *pinaphidis*
- Antenna 21–22 segmented. Mesonotum with dispersed large circular pits (distance

- between pits variable) and coarse rugosities in the distal half (Fig. 5) *bicolor*
- 4(1). Antenna 16–17 segmented. Propodeum with distinct areola which has a few cross-carinae inside, otherwise almost smooth (Fig. 2) *ahtanumensis*
- Antenna with 18 or more segments. Propodeum with the areola bearing a few cross-carinae, or cross-carinated and rugose (Figs. 10, 17) 5
- 5(4). Antenna 18–19 or 19–20 segmented. Mesonotum uniformly feebly rugose, without pits (Figs. 24, 25). Propodeum with areola smooth inside and lateral carinae distinct (Fig. 10), or with irregular carinae to rugosities inside and with lateral carinae irregular (Fig. 29). Ovipositor sheath oval (Fig. 31) or broadly oval (Fig. 11) 6
- Antenna 22–23 segmented. Mesonotum finely granulate-rugose, with a few circular pits (Fig. 16). Propodeum with areola with coarse rugosities and numerous cross-carinae inside, sometimes longitudinal carinae less distinct (Fig. 17). Ovipositor sheath broadly oval, curved on lower side (Fig. 18) *xanthothera*
- 6(5). Body coloration generally dark brown to black, with yellowish patterns on mesosoma. Metasoma ferrugineous. Propodeum (Fig. 10) with distinct, well-determined complete areola, almost smooth inside. Antenna 19–20 segmented *juniperaphidis*
- Body coloration prevalently yellow, with brownish patterns on mesopleura and metanotum. Propodeum (Fig. 29) with the areola complete, with irregular carinae to rugosities inside, lateral longitudinal carinae irregular to rugose. Antenna 18–19 (17, 20) segmented *columbiana*

ACKNOWLEDGMENTS

We express thanks to the following: D. R. Smith (Systematic Entomology Laboratory, USDA, Washington, DC) and Paul M. Marsh (same lab, retired) for arranging for the loan of USNM material; R. L. Blinn (Dept. of Entomology, North Carolina State University, Raleigh) for the loan of material from the C. F. Smith collection; and the late C. F. Smith for his kindness in supplying some material, including paratypes.

LITERATURE CITED

Gahan, A. B. 1911. Aphidiinae of North America. Maryland Agriculture Experiment Station Bulletin 152: 147–200.

- Huber, J. T. and M. J. Sharkey. 1993. Structure, pp. 13–59. In Goulet, H. and J. T. Huber, eds. Hymenoptera of the World: An Identification Guide to Families. Research Branch, Agriculture Canada, Ottawa, Ontario, Publication 1894/E, 668 pp.
- Kiriác, I. 1993. Parasites of the genus *Pauesia* Quilis (Hymenoptera, Aphidiidae), and description of two new species. Bulletin of the Academy of Sciences of the Moldova Republic, Biological and Chemical Sciences, 1993 (No. 4): 40–44. (In Moldovian.)
- Mackauer, M. 1968. Pars 3. Aphidiidae, pp. 1–103. In Ferriere, C. and J. van der Vecht, eds. Hymenopterorum Catalogus (nova editio), Dr. W. Junk, The Hague.
- Mackauer, M. and P. Starý. 1967. Hym. Ichneumonidea, World Aphidiidae. In Delucchi, V. and G. Remaudière, eds. Index of Entomophagous Insects, LeFrancois, Paris, 167 pp.
- Marsh, P. M. 1979. Aphidiidae, pp. 295–313. In Krombein, K. V., P. D. Hurd, D. R. Smith, and B. D. Burks, eds. Catalog of Hymenoptera in America North of Mexico. Vol. 1, Symphyta and Apocrita (Parasitica). Smithsonian Institution Press, Washington, DC, 1198 pp.
- . 1991. A new species of *Pauesia* (Hymenoptera: Braconidae: Aphidiinae) from Georgia and introduced into South Africa against the black pine aphid (Homoptera: Aphididae). Journal of Entomological Science 26: 81–84.
- Pike, K. S. and P. Starý. 1996. New species of *Pauesia* (Hymenoptera: Braconidae: Aphidiinae) parasitoids on *Cinara* (Homoptera: Aphididae: Lachninae) associated with conifers in the Pacific Northwest. Proceedings of the Entomological Society of Washington 98: 324–331.
- Pike, K. S., P. Starý, R. Miller, D. Allison, L. Boydston, G. Graf, and T. Miller. 1996. New species and host records of aphid parasitoids (Hymenoptera: Braconidae: Aphidiinae) from the Pacific Northwest, U.S.A. Proceedings of the Entomological Society of Washington 98: 570–591.
- Pike, K. S., P. Starý, T. Miller, G. Graf, D. Allison, L. Boydston, and R. Miller. 2000. Aphid parasitoids (Hymenoptera: Braconidae: Aphidiinae) of Northwest USA. Proceedings of the Entomological Society of Washington 102: 688–740.
- Sedlag, U. 1971. Strukturelle Anpassungen und evolutive Trends in der Gattung *Pauesia* (Hymenoptera, Aphidiidae). Proceedings, 13th International Congress of Entomology, Moscow, 1968, pp. 298–299.
- Sedlag, U. and P. Starý. 1980. *Pauesia* (*Pauesiella*) *spatulata* sp. n., a parasitoid of *Cinara*-aphids from Central Europe (Hymenoptera, Aphidiidae; Homoptera, Lachnidae). Acta Entomologica Bohemoslovaca 77: 383–386.
- Smith, C. F. 1944. The Aphidiinae of North America (Braconidae: Hymenoptera). Ohio State University Contributions in Zoology and Entomology No. 6, 154 pp.
- Starý, P. 1976. External female genitalia of the Aphidiidae (Hymenoptera). Acta Entomologica Bohemoslovaca 73: 102–112.
- Starý, P. and G. Remaudière. 1982. New genera, species and host records of aphid parasitoids (Hymenoptera, Aphidiidae) from Mexico. Annales de la Société Entomologique de France, N.S. 18: 107–127.